# FRS140D, FRS140R, FRS140H

## 17A, 100V, 0.145 Ohm, Rad Hard, N-Channel Power MOSFETs

June 1998

### Features

- **17A, 100V, RDS(on) = 0.145Ω**
- **Second Generation Rad Hard MOSFET Results From New Design Concepts**
- **Gamma**
  - **Meets Pre-Rad Specifications to 100KRAD(Si)**
  - **Defined End Point Specs at 300KRAD(Si) and 1000KRAD(Si)**
  - **Performance Permits Limited Use to 3000KRAD(Si)**
- **Gamma Dot**
  - **Survives 3E9RAD(Si)/sec at 80% BVDSS Typically**
  - **Survives 2E12 Typically If Current Limited to IDM**
- **Photo Current**
  - **3.0nA Per-RAD(Si)/sec Typically**
- **Neutron**
  - **Pre-RAD Specifications for 3E13 Neutrons/cm$^2$**
  - **Usable to 3E14 Neutrons/cm$^2$**

### Description

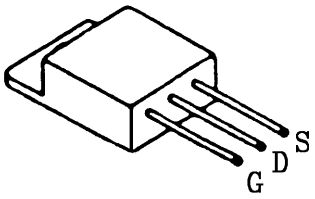
The Intersil Corporation has designed a series of SECOND GENERATION hardened power MOSFETs of both N and P channel enhancement types with ratings from 100V to 500V, 1A to 60A, and on resistance as low as 25mW. Total dose hardness is offered at 100K RAD(Si) and 1000KRAD(Si) with neutron hardness ranging from 1E13n/cm$^2$ for 500V product to 1E14n/cm$^2$ for 100V product. Dose rate hardness (GAMMA DOT) exists for rates to 1E9 without current limiting and 2E12 with current limiting.

This MOSFET is an enhancement-mode silicon-gate power field effect transistor of the vertical DMOS (VDMOS) structure. It is specially designed and processed to exhibit minimal characteristic changes to total dose (GAMMA) and neutron ($n^o$) exposures. Design and processing efforts are also directed to enhance survival to heavy ion (SEU) and/or dose rate (GAMMA DOT) exposure.

This part may be supplied as a die or in various packages other than shown above. Reliability screening is available as either non TX (commercial), TX equivalent of MIL-S-19500, TXV equivalent of MIL-S-19500, or space equivalent of MIL-S-19500. Contact the Intersil High-Reliability Marketing group for any desired deviations from the data sheet.

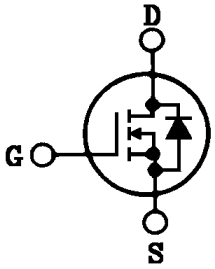
### Package

**TO-257AA**




CAUTION: Beryllia Warning per MIL-S-19500 refer to package specifications.

### Symbol




### Absolute Maximum Ratings (TC = +25$^o$C) Unless Otherwise Specified

| | | FRS140D, R, H | UNITS |
|---|---|---|---|
| Drain-Source Voltage | VDS | 100 | V |
| Drain-Gate Voltage (RGS = 20kΩ) | VDGR | 100 | V |
| Continuous Drain Current | | | |
| TC = +25$^o$C | ID | 17 | A |
| TC = +100$^o$C | ID | 11 | A |
| Pulsed Drain Current | IDM | 51 | A |
| Gate-Source Voltage | VGS | ±20 | V |
| Maximum Power Dissipation | | | |
| TC = +25$^o$C | PT | 75 | W |
| TC = +100$^o$C | PT | 30 | W |
| Derated Above +25$^o$C | | 0.60 | W/$^o$C |
| Inductive Current, Clamped, L = 100μH, (See Test Figure) | ILM | 51 | A |
| Continuous Source Current (Body Diode) | IS | 17 | A |
| Pulsed Source Current (Body Diode) | ISM | 51 | A |
| Operating And Storage Temperature | TJC, TSTG | -55 to +150 | $^o$C |
| Lead Temperature (During Soldering) | | | |
| Distance > 0.063 in. (1.6mm) From Case, 10s Max | TL | 300 | $^o$C |

CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.



File Number **3254.2**

**Pre-Radiation Electrical Specifications** $T_C$ = +25°C, Unless Otherwise Specified

| PARAMETER | SYMBOL | TEST CONDITIONS | LIMITS MIN | LIMITS MAX | UNITS |
|---|---|---|---|---|---|
| Drain-Source Breakdown Volts | BVDSS | VGS = 0, ID = 1mA | 100 | - | V |
| Gate-Threshold Volts | VGS(th) | VDS = VGS, ID = 1mA | 2.0 | 4.0 | V |
| Gate-Body Leakage Forward | IGSSF | VGS = +20V | - | 100 | nA |
| Gate-Body Leakage Reverse | IGSSR | VGS = -20V | - | 100 | nA |
| Zero-Gate Voltage Drain Current | IDSS1<br>IDSS2<br>IDSS3 | VDS = 100V, VGS = 0<br>VDS = 80V, VGS = 0<br>VDS = 80V, VGS = 0, TC = +125°C | -<br>-<br>- | 1<br>0.025<br>0.25 | mA |
| Rated Avalanche Current | IAR | Time = 20µs | - | 51 | A |
| Drain-Source On-State Volts | VDS(on) | VGS = 10V, ID = 17A | - | 2.59 | V |
| Drain-Source On Resistance | RDS(on) | VGS = 10V, ID = 11A | - | 0.145 | Ω |
| Turn-On Delay Time | td(on) | VDD = 50V, ID = 17A | - | 60 | ns |
| Rise Time | tr | Pulse Width = 3µs | - | 320 | |
| Turn-Off Delay Time | td(off) | Period = 300µs, RG = 25Ω | - | 290 | |
| Fall Time | tf | 0 ≤ VGS ≤ 10 (See Test Circuit) | - | 260 | |
| Gate-Charge Threshold | QG(th) | VDD = 50V, ID = 17A<br>IGS1 = IGS2<br>0 ≤ VGS≤ 20 | 1 | 6 | nc |
| Gate-Charge On State | QG(on) | | 32 | 130 | |
| Gate-Charge Total | QGM | | 60 | 240 | |
| Plateau Voltage | VGP | | 3 | 14 | V |
| Gate-Charge Source | QGS | | 5 | 22 | nc |
| Gate-Charge Drain | QGD | | 18 | 74 | |
| Diode Forward Voltage | VSD | ID = 17A, VGD = 0 | 0.6 | 1.8 | V |
| Reverse Recovery Time | TT | I = 17A; di/dt = 100A/µs | - | 800 | ns |
| Junction-To-Case | Rθjc | - | - | 1.67 | °C/W |
| Junction-To-Ambient | Rθja | Free Air Operation | - | 60 | |

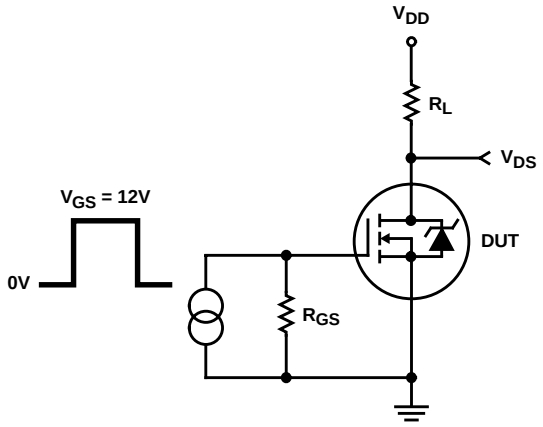



FIGURE 1. RESISTIVE SWITCHING TEST CIRCUIT

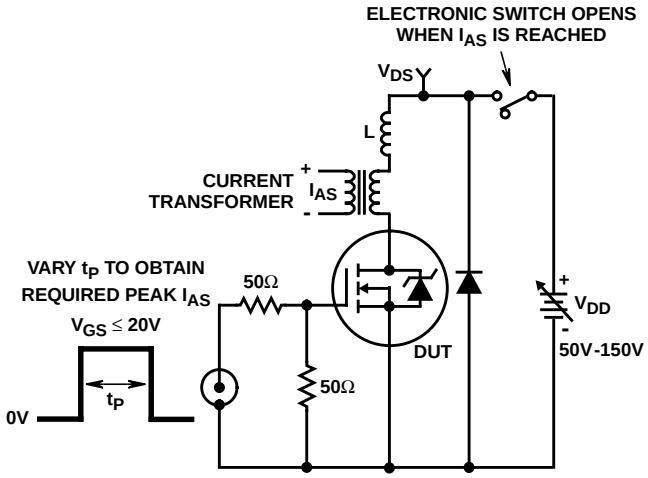



FIGURE 2. UNCLAMPED ENERGY TEST CIRCUIT

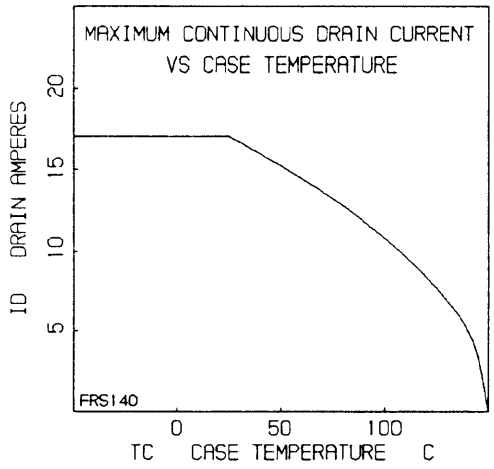
**Post-Radiation Electrical Specifications** $T_C = +25^oC$, Unless Otherwise Specified

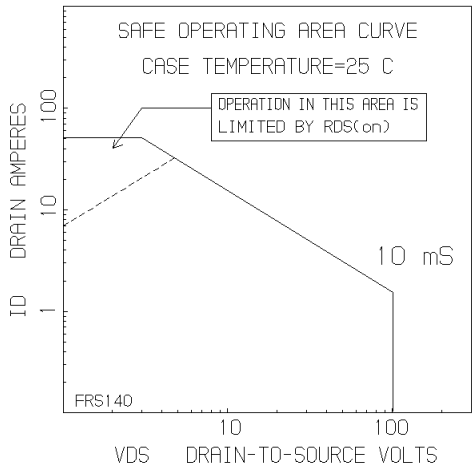
| PARAMETER | | SYMBOL | TYPE | TEST CONDITIONS | LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | |
| Drain-Source Breakdown Volts | (Note 4, 6) | BVDSS | FRS140D, R | VGS = 0, ID = 1mA | 100 | - | V |
| | (Note 5, 6) | BVDSS | FRS140H | VGS = 0, ID = 1mA | 95 | - | V |
| Gate-Source Threshold Volts | (Note 4, 6) | VGS(th) | FRS140D, R | VGS = VDS, ID = 1mA | 2.0 | 4.0 | V |
| | (Note 3, 5, 6) | VGS(th) | FRS140H | VGS = VDS, ID = 1mA | 1.5 | 4.5 | V |
| Gate-Body Leakage Forward | (Note 4, 6) | IGSSF | FRS140D, R | VGS = 20V, VDS = 0 | - | 100 | nA |
| | (Note 5, 6) | IGSSF | FRS140H | VGS = 20V, VDS = 0 | - | 200 | nA |
| Gate-Body Leakage Reverse | (Note 2, 4, 6) | IGSSR | FRS140D, R | VGS = -20V, VDS = 0 | - | 100 | nA |
| | (Note 2, 5, 6) | IGSSR | FRS140H | VGS = -20V, VDS = 0 | - | 200 | nA |
| Zero-Gate Voltage Drain Current | (Note 4, 6) | IDSS | FRS140D, R | VGS = 0, VDS = 80V | - | 25 | µA |
| | (Note 5, 6) | IDSS | FRS140H | VGS = 0, VDS = 80V | - | 100 | µA |
| Drain-Source On-State Volts | (Note 1, 4, 6) | VDS(on) | FRS140D, R | VGS = 10V, ID = 17A | - | 2.59 | V |
| | (Note 1, 5, 6) | VDS(on) | FRS140H | VGS = 16V, ID = 17A | - | 3.89 | V |
| Drain-Source On Resistance | (Note 1, 4, 6) | RDS(on) | FRS140D, R | VGS = 10V, ID =11A | - | 0.145 | Ω |
| | (Note 1, 5, 6) | RDS(on) | FRS140H | VGS = 14V, ID =11A | - | 0.218 | Ω |

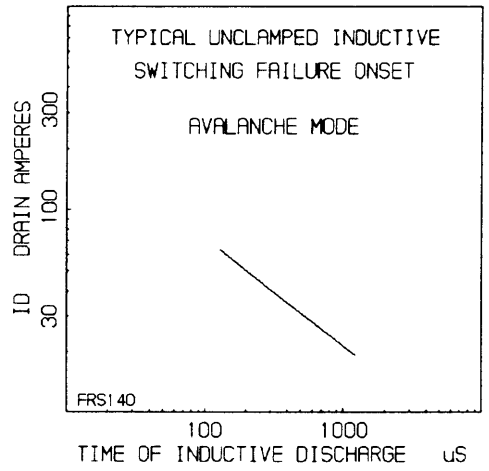
NOTES:

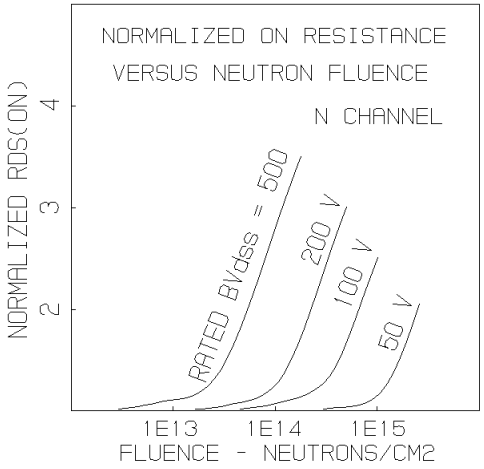
1. Pulse test, 300µs max
2. Absolute value
3. Gamma = 300KRAD(Si)
4. Gamma = 10KRAD(Si) for “D”, 100KRAD(Si) for “R”. Neutron = 3E13
5. Gamma = 1000KRAD(Si). Neutron = 3E13
6. Insitu Gamma bias must be sampled for both VGS = +10V, VDS = 0V and VGS = 0V, VDS = 80% BVDSS
7. Gamma data taken 6/25/90 on TA 17641 devices by GE ASTRO SPACE; EMC/SURVIVABILITY LABORATORY; KING OF PRUSSIA, PA 19401
8. Single event drain burnout testing by Titus, J.L., et al of NWSC, Crane, IN at Brookhaven Nat. Lab. Dec 11-14, 1989
9. Neutron derivation, Intersil Application note AN-8831, Oct. 1988

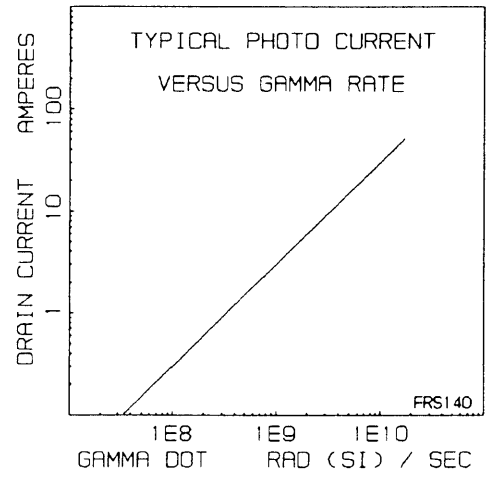
## *Typical Performance Characteristics*

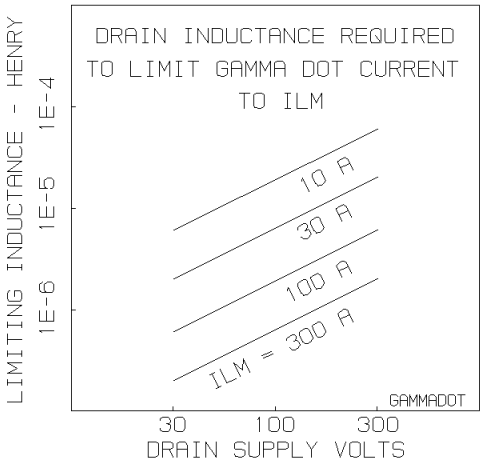


## Rad Hard Data Packages - Intersil Power Transistors

**TXV Equivalent**

**1. Rad Hard TXV Equivalent - Standard Data Package**

A. Certificate of Compliance

B. Assembly Flow Chart

C. Preconditioning - Attributes Data Sheet

D. Group A - Attributes Data Sheet

E. Group B - Attributes Data Sheet

F. Group C - Attributes Data Sheet

G. Group D - Attributes Data Sheet

**2. Rad Hard TXV Equivalent - Optional Data Package**

A. Certificate of Compliance

B. Assembly Flow Chart

C. Preconditioning
- Attributes Data Sheet
- Precondition Lot Traveler
- Pre and Post Burn-In Read and Record Data

D. Group A
- Attributes Data Sheet
- Group A Lot Traveler

E. Group B
- Attributes Data Sheet
- Group B Lot Traveler
- Pre and Post Read and Record Data for Intermittent Operating Life (Subgroup B3)
- Bond Strength Data (Subgroup B3)
- Pre and Post High Temperature Operating Life Read and Record Data (Subgroup B6)

F. Group C
- Attributes Data Sheet
- Group C Lot Traveler
- Pre and Post Read and Record Data for Intermittent Operating Life (Subgroup C6)
- Bond Strength Data (Subgroup C6)

G. Group D
- Attributes Data Sheet
- Group D Lot Traveler
- Pre and Post RAD Read and Record Data

**Class S - Equivalents**

**1. Rad Hard "S" Equivalent - Standard Data Package**

A. Certificate of Compliance

B. Serialization Records

C. Assembly Flow Chart

D. SEM Photos and Report

E. Preconditioning Attributes Data Sheet
Hi-Rel Lot Traveler
HTRB - Hi Temp Gate Stress Post Reverse Bias Data and Delta Data
HTRB - Hi Temp Drain Stress Post Reverse Bias Delta Data

F. Group A - Attributes Data Sheet

G. Group B - Attributes Data Sheet

H. Group C - Attributes Data Sheet

I. Group D - Attributes Data Sheet

**2. Rad Hard Max. "S" Equivalent - Optional Data Package**

A. Certificate of Compliance

B. Serialization Records

C. Assembly Flow Chart

D. SEM Photos and Report

E. Preconditioning
- Attributes Data Sheet
- Hi-Rel Lot Traveler
- HTRB - Hi Temp Gate Stress Post Reverse Bias Data and Delta Data
- HTRB - Hi Temp Drain Stress Post Reverse Bias Delta Data
- X-Ray and X-Ray Report

F. Group A
- Attributes Data Sheet
- Hi-Rel Lot Traveler
- Subgroups A2, A3, A4, A5 and A7 Data

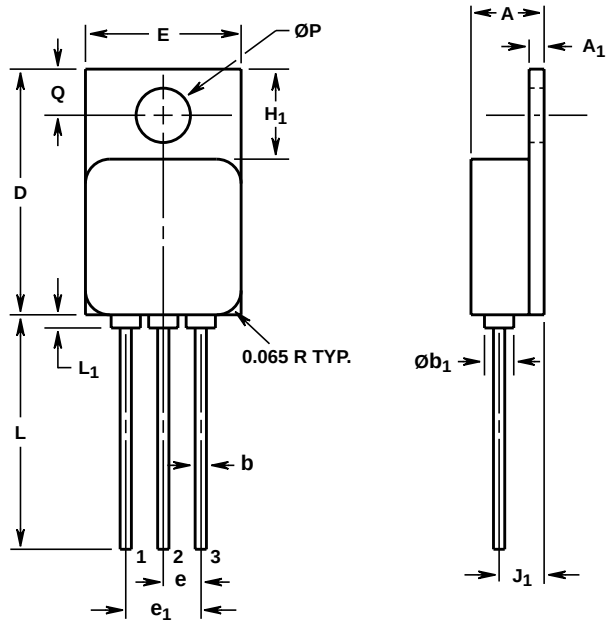
G. Group B
- Attributes Data Sheet
- Hi-Rel Lot Traveler
- Subgroups B1, B3, B4, B5 and B6 Data

H. Group C
- Attributes Data Sheet
- Hi-Rel Lot Traveler
- Subgroups C1, C2, C3 and C6 Data

I. Group D
- Attributes Data Sheet
- Hi-Rel Lot Traveler
- Pre and Post Radiation Data

## *TO-257AA*

**3 LEAD JEDEC TO-257AA HERMETIC METAL PACKAGE**




| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | 0.190 | 0.200 | 4.83 | 5.08 | - |
| $A_1$ | 0.035 | 0.045 | 0.89 | 1.14 | - |
| Øb | 0.025 | 0.035 | 0.64 | 0.88 | 2, 3 |
| $Øb_1$ | 0.060 | 0.090 | 1.53 | 2.28 | - |
| D | 0.645 | 0.665 | 16.39 | 16.89 | - |
| E | 0.410 | 0.420 | 10.42 | 10.66 | - |
| e | 0.100 TYP | | 2.54 TYP | | 4 |
| $e_1$ | 0.200 BSC | | 5.08 BSC | | 4 |
| $H_1$ | 0.230 | 0.250 | 5.85 | 6.35 | - |
| $J_1$ | 0.110 | 0.130 | 2.80 | 3.30 | 4 |
| L | 0.600 | 0.650 | 15.24 | 16.51 | - |
| $L_1$ | - | 0.035 | - | 0.88 | - |
| ØP | 0.140 | 0.150 | 3.56 | 3.81 | - |
| Q | 0.113 | 0.133 | 2.88 | 3.37 | - |

NOTES:

1. These dimensions are within allowable dimensions of Rev. B of JEDEC TO-257AA dated 9-88.
2. Add typically 0.002 inches (0.05mm) for solder coating.
3. Lead dimension (without solder).
4. Position of lead to be measured 0.150 inches (3.81mm) from bottom of dimension D.
5. Die to base BeO isolated, terminals to case ceramic isolated.
6. Controlling dimension: Inch.
7. Revision 1 dated 1-93.

# WARNING!

**BERYLLIA WARNING PER MIL-S-19500**

Packages containing beryllium oxide (BeO) shall not be ground, machined, sandblasted, or subject to any mechanical operation which will produce dust containing any beryllium compound. Packages containing any beryllium compound shall not be subjected to any chemical process (etching, etc.) which will produce fumes containing beryllium or its' compounds.



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